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MAJOR DISEASES ASSOCIATED WITH GROUNDWATER POLLUTION A CASE STUDY OF MATHURA DISTRICT, UTTAR PRADESH (INDIA)

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Abstract

This study seeks to investigate major diseases associated with the groundwater pollution. It is one of the major issues in the developing world like India and the ratio of such diseases are increasing in urban as well as rural areas of India. This study based on GIS techniques to examine the spatial variation in water quality index in the study area. The data for the study was collected with the help of questionnaire interviews from 2500 households as well as 50 groundwater samples were collected from all 10 blocks of Mathura district, and analyzed in the laboratory under the guidelines of WHO and BIS 10500. The secondary data of reported cases regarding major diseases associated with groundwater were collected from local public health units which people mostly visit. The results show that most of the diseases are caused by the poor uncovered sanitary system, contaminated groundwater and lack of awareness. Continued neglect and underestimation of these factors may increase health risks in the study area in the future. It was found that the groundwater in Mathura District is non-potable due to the presence of iron, Total harness (TH), Fluoride, chloride and total dissolved solids (TDS). Most of the chemical parameters in the groundwaters of study area above the WHO recommendations for drinking water guidelines, and study reported the occurrence of major diseases associated with groundwater pollution like Fluorosis, Kidney stone formation, Typhoid, cholera, Blue Baby Syndrome, Hepatitis A, and cases related to the any other problems (Dysentery, Diarrhea, stomach, hair and skins problems and Polio (Infantile Paralysis)). The study points to the need of creating awareness among the people.

Keywords: Groundwater pollution, TDS, WHO, BIS; Major diseases. water quality, water quality index.

Introduction

The provision of safe water is important as air to breathe. Groundwater pollution is recognized as a significant source of potential health risk to exposed populations throughout the world. As per the Central Pollution Control Board (CPCB), 61 percent of urban sewage is discharged into rivers and other water bodies without treatment. Groundwater contamination is impacting both rural and urban areas. A CPCB study states that groundwater in 276 districts of India is contaminated with fluoride, arsenic and nitrate beyond permissible limits. Excessive use of pesticides and chemical fertilizers in agriculture contributes to groundwater pollution. Industrial activities release various pollutants into groundwater and water bodies, which contribute to water pollution (Gupta, D.N., 2023).

Industrialization, urban life and agricultural production have resulted in environmental degradation and pollution, adversely affecting water bodies (rivers and oceans) essential for life, ultimately affecting human health and sustainable social development (Xu et al., 2022a).

Rural areas also face severe challenges related to water contamination, especially due to open defecation, uncovered sewage channel and poor sanitation facilities, and agricultural runoff. Many rural communities rely on hand pumps or wells for drinking water, which are susceptible to contamination from nearby sources. Globally, an estimated 80% of industrial and municipal wastewater is discharged into the environment without any prior treatment, with adverse effects on human health and ecosystems. This proportion is higher in the least developed countries, where sanitation and wastewater treatment facilities are severely lacking (Lin et al., 2022).

Men aged 31–45 years, living in rural areas, having low educational and socio-economic status, having inadequate water intake, high sodium diet, personal history of kidney stones, and being overweight are at higher risk of urolithiasis (Waqas M. et al., 2024). An elevated TDS concentration can lead to the formation of deposits that can crystallize into kidney stone, as a consequence of crystal deposition in the urinary tract. (Dr. Saurabh Jain 2024)

Access to clean water is one of our most basic human needs. However, one in four people in the world does not have access to safe drinking water, which is a major health risk. Unsafe water is responsible for more than a million deaths each year (ourworldindata.).

(K.S. Rawat et. al.,2012) recorded in their study area (Mathura District) highest level of fluoride in groundwater upto the 4.5mg/l. Turbidity in water can serve as a breeding ground for waterborne bacteria, viruses and protozoa, which can stick to or be absorbed by water particles. Diseases can be largely prevented through improved access to safe water supply by providing periodic monitoring of quality, adequate sanitation facilities and improved hygiene practices, especially in developing countries (Nanda Balan et al., 2012).

(Krishna Kumar Yadav et. al., 2012) in their study reported that all groundwater do not comply with the standards of the World Health Organization and Indian Standards-10500-91, and suggested precautionary measures before drinking groundwater in the Agra district, so that adverse health effects on humans can be prevented. (Salman et al., 2018) found that water quality in most parts of the mathura district, Uttar pradesh is unsuitable for drinking and irrigation purpose.

India has been ranked 141 out of 180 countries in the Yale University's Unsafe Drinking Water Index 2022. Drinking water is not readily available to people in the world in the desired quantity and quality. This is a common problem in developing countries and is leading to an increase in the rate of waterborne diseases. Several waterborne diseases such as diarrhoea, cholera, typhoid, hepatitis A, dermatitis and enteric fever pose a persistent threat to human health in the surrounding communities, especially to children and the elderly (Butt and Iqbal, 2007).

The communities which are struggling against waterborne diseases like cholera, diarrhoea, gastrointestinal issues and related diseases, are facing high death rate annually (WHO, 2015). In these waterborne diseases, diarrhoea is one of the major diseases, which is directly caused by poor water quality and sanitation system. Diarrhoea affects more than 4

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billion people and caused 1.8 million deaths annually and 90% of the deaths are children under five years old. Cholera is another serious waterborne disease, which is caused by a bacterial infection those outbreaks due to poor quality of drinking water and sanitation system, and poor hygiene behaviour. It has been reported that more than 120,000 people effected by cholera every year in the world. Typhoid is the third most common diseases in waterborne diseases which is caused by the contaminated water or food as well as uncovered sanitary channels born mosquitoes. More than 12 million cholera cases reported in the world annually UNICEF (2019)

Study Area

Mathura District is a medium-sized district in terms of population as well as area. it lies between latitudes 27° 14′ and 27° 17′ N and longitudes 77° 17′ and 78° 12′ E and bordered by the Gurgaon district of Haryana state in the North and Bharatpur district of Rajasthan state in the Northwest. In the northeastern and eastern sides, it is bounded by Aligarh and on the south by the district of Agra, was selected as the study area. which is shown in Figure 1. It come under Survey of India Toposheet No. 54E and 54 IS. The total geographical area of the district is 3303 square kilometres. It is about 141 kms away from the country’s capital, New Delhi. Yamuna River flows from north to south through the Mathura district which divides the district into two physical units- western and eastern. The average monthly maximum temperature ranges between 36º C and 47º C in summer and 25º C and 32º C in winter and the annual rainfall is 826 mm. During pre-monsoon periods the water is 2.65 to 14.34 m below ground level (bgl) and during post-monsoon, the levels are between 1.33 to 14.0 m bgl (CGWB, 2012). The persistent problem of high salinity and concentrations of other chemicals in groundwater is reported in previous studies (CGWB, 2012).

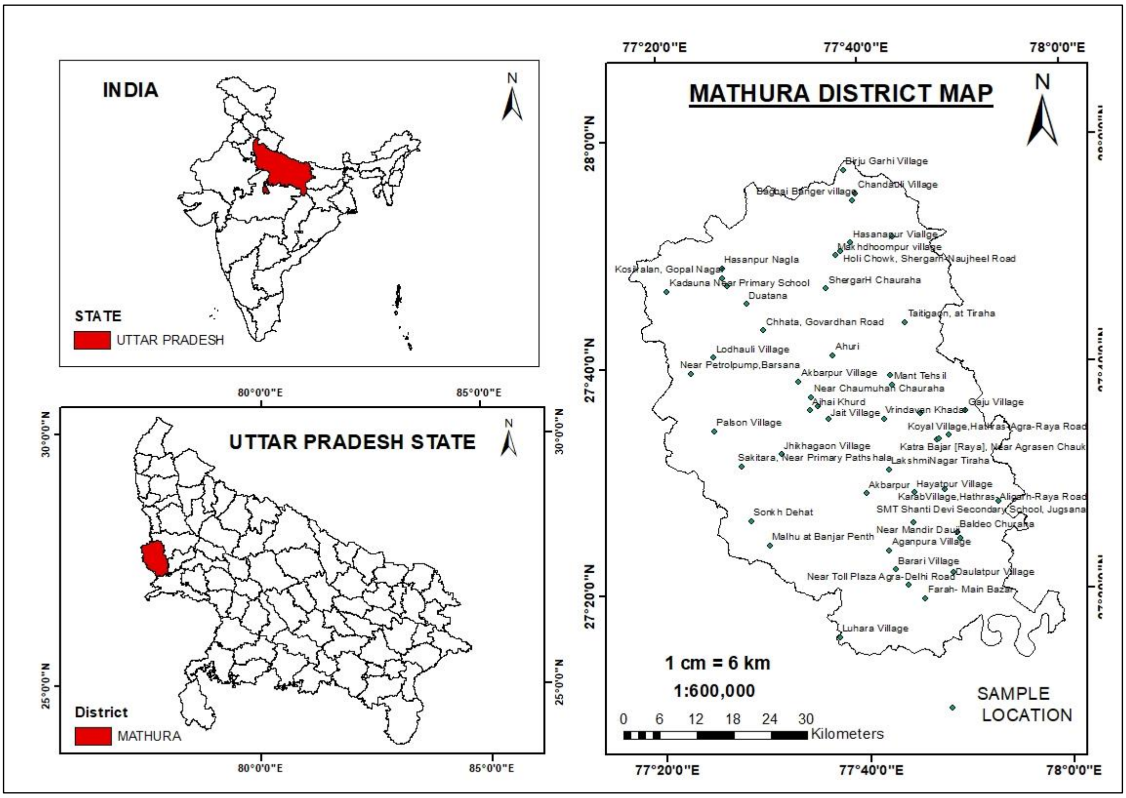

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Figure: 1- Location of study area and sites of groundwater samples collected for analytical analysis in Mathura district (UttarPradesh), India.

Materials and Methods

The study based on both primary and secondary data as well. A field survey was directed for data collection about the major diseases related to groundwater pollution with the help of a 2500 sampled households/people respondents. Accordingly, secondary data was collected from public hospitals and local Dispensary Units. Total 50 Groundwater samples were collected from different government and domestic hand pumps during October-December (2023) from all 10 blocks of study area at those sites which are under the maximum users of the community for drinking and other domestic purposes, representing the post-monsoon season. The location of the sampling sites is shown in Figure 1. ArcGIS 10 is used to map and analyze the data for the analysis of groundwater quality. to collect the samples High density polyethylene (HDPE) bottles were used. The samples were filled completely and immediately sealed to avoid exposure to air and systematically labeled. The labeled samples were analyzed for various physico-chemical parameters in the laboratory.

During sample collection, (handling and preservation) standard procedures recommended by the American Public Health Association (APHA 2005) and (Adoni et al., 1985) were followed to ensure data quality and consistency. The groundwater characterization has been carried out for the parameters like pH, Turbidity, Electrical Conductivity (EC), total dissolved solids (TDS), total hardness (TH), calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^{-}), nitrate ($NO3^{-}$), Iron (Fe) and fluoride (F^{-}). The obtained results were compared World Health Organization (WHO) and Bureau of Indian Standards 10500 (BIS). TDS and electrical conductivity measured by Fisher AB-200 digital meter, and pH by Fisher AB-150. Calcium (Ca2+), Magnesium, Total hardness (TH), and chloride (Cl-) were analysed by volumetric titration method. Nitrate (NO3-) was analysed by UV spectrophotometer.

To determine the fluoride in groundwater samples Colorimetric method (SPANDS) was used. While Iron was analyzed by the phenanthroline method. At 25ºC, the concentration of EC is expressed in microsiemens/cm whereas TDS, Ca, TH, NO3, Mg, Cl, Iron (Fe) and Fluoride are expressed in mg /l.

Water Quality Index (WQI)

Water quality index (WQI) is an exceptionally valuable tool for evaluating the overall quality of water (Ketata et al., 2012), and with its help, a large number of data can be shown in a single value and facilitates easy understanding of the information. Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables and the calculation of WQI was made (Brown et al., 1972) by using the following equation:

$$\mathbf{WQI} = \sum \mathbf{QnWn} / \sum \mathbf{Wn}$$

The quality rating scale (Qi) for each parameter is calculated by using this expression:

$$\mathbf{Qn} = \mathbf{100}[(\mathbf{Vn} - \mathbf{Vo}/\mathbf{Sn} - \mathbf{Vo})]$$

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Vn is estimated concentration of ith parameter in the analysed water
Vo is the ideal value of this parameter in pure water
Vo = 0 (except pH =7.0 and DO = 14.6 mg/l)
Sn is recommended standard value of ith parameter
The unit weight (Wi) for each water quality parameter is calculated by using the following formula:

$$\mathbf{Wn = K/Sn}$$

K= proportional constant.

The computed WQI values are categorized into five categories as "excellent water" to "water, unsuitable for drinking". The range for WQI for drinking purpose is tabulated in Table 1.

Table 1: Classification of Groundwater quality according to WQI range

S.NO.	WQI range	Water Quality
1.	<50	Excellent Water
2.	50-100	Good water
3.	100-200	Poor water
4.	200-300	Very poor water
5.	>300	Unsuitable for drinking purpose

Result and discussions: The physicochemical concentrations of collected groundwater samples for the various parameters like maximum, minimum and mean are shown in Table No.1.

pH indicates whether a solution is acidic, neutral or basic. It is a measure of hydrogen ion concentration value in water. The pH required has to be in the range of 6.5–8.5 for the drinking purpose (BIS, 2012). In present study pH concentration is ranges from 6.6 to 8.2 which shows that it is within the permissible limit as prescribed by BIS (2012).

Turbidity: it tells about the clarity of water. High turbidity causes the water to appear cloudy or muddy. This is due to the presence of particulate matter such as clay or sludge, finely divided organic matter, etc. Turbidity is an optical property of water, not a chemical or biological measurements. Caution should be exercised when using turbidity as a measure of water quality, as high levels of turbidity do not necessarily indicate poor water quality, and low levels of turbidity do not necessarily indicate good water quality. Values should, therefore, be evaluated alongside other parameters. The turbidity in the groundwater samples was determined using the Turbidity meter following Nephelometric method. This method is based on comparison of the intensity of light scattered by sample and standard reference under defined condition. This method is applicable in the range of turbidity 0-40 NTU (nephelometric turbidity units). In present study, turbidity in groundwater samples ranges from 0.9 to 10.1 was observed.

Total Dissolved Solids (TDS): Total dissolved solids, the concentration of total inorganic salts and a small amount of organic salts dissolved in the water is another important physio-chemical parameter determining the water quality. TDS in groundwater samples ranges from

610 mg/l to 8160 mg/l with a mean of 2624 mg/l. However, the desirable limit of TDS study area is higher than the permissible limit indicating severe contamination and health threat. High TDS increase density of water, decrease solubility of gases like oxygen and ultimately make the water unsuitable for drinking (WHO, 1984). High TDS levels (>500mg/L) result in excessive scaling in water heaters, water pipes, boilers and household appliances (Tihansky, 1974). Similar results were also reported for TDS of groundwater in Bhanpur Bhopal (Hurra and Bhavsar, 2021). All 50 collected samples in this study region are higher than the permissible limit (WHO, 2017).

Electrical conductivity (EC): Electrical conductivity, the measure of water capacity to convey the electrical current is one of the important physio-chemical parameters determining the water quality. The highest desirable limit of EC in drinking water is 750 µS/cm (WHO 2016). The observed value of EC in water samples is between 940 and 12855 µS/cm with a mean of 3917µS/cm in of 50 sample. 48 samples have value higher than 1000 µS/cm in the study region. The observed value of EC represents the ability of the water to conduct electric current in which higher EC indicates enrichment of salts in the groundwater (Logeshkumaran et al., 2015).

Total Hardness (TH): Total hardness refers to the sum of the calcium and magnesium concentration in water, and both expressed as CaCO3 in mg/l. Total hardness is calculated using the following equation:

$$\textbf{Total hardness (mg/l)} = \frac{\textbf{volume of titrant(t)} \times 1000}{\textbf{Volume of sample}}$$

Total hardness is one of the most important parameters in water quality assessment. The TH in the study area varies between 205 to 1920 with a mean value of 684 mg/l. The WHO standard for TH is 500 mg/l (All 50 samples of study region fall outside this range). Hardness reflects the composite measure of polyvalent cations whereas calcium and magnesium are the primary constituent of hardness (Larry, 1996).

Calcium and Magnesium: Magnesium is an essential element for human being, it is important for normal bone structure in the body. Water with high levels of magnesium or calcium is considered as hard and is undesirable for domestic purposes. The values of calcium range from 22 mg/l to 193 mg/l with a mean value of 61.3 mg/l (Table 1). Magnesium concentration is very high in the groundwater samples. Observed data shows most parts of the study area have value in the non-permissible category. It ranges from 44.4 mg/l to 419 mg/l with a mean of 150.71mg/l.

The calcium hardness was calculated by using the formula:

$$\textbf{Calcium hardness mgl-1 as } CaCO_3 = \frac{\textbf{Volume of titrant(t) used x1000x1.05}}{\textbf{Volume of sample}}$$

And Magnesium concentration was calculated by subtracting calcium hardness from total hardness of ground water.

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Mg (mg/l) = [Total hardness (as CaCO3mg/l) – Calcium hardness (as CaCO3 mg/l)] × 0.244

Chloride (Cl): Chloride in excess imparts a salty taste to water, and people who are allergic to high chloride are subjected to laxative effects (Anitha et al., 2011); (Sadat-Noori et al. 2014). In the study area chloride concentration ranges from 54 mg/l to 2481 mg/l. Chlorides are found in natural water due to leaching of chloride containing rocks and soils discharges of effluents from chemical industries such as sewage disposal, ice-cream plant effluent, irrigation drainage. Higher concentration of chloride is harmful which causes disease related to heart and kidney of the people, indigestion, taste, palatability and corrosion are also affected. 62 percent samples are found to be value higher than desirable limit of Chloride prescribed by BIS, 2012) for drinking water (Table-2). The results were expressed in mgl-1.

The chloride content was calculated by using formula:

$$\text{Chloride in mgl}^{-1} = \frac{\text{Volume of titrant(t)used x N x 35.46 x 1000}}{\text{Volume of sample}}$$

Where, N= normality of $AgNo_3$ (0.0141 N)

Fluoride (F): Fluoride in drinking water is mainly due to the geogenic sources. Fluoride at low concentrations has a beneficial effect on teeth by preventing and reducing the risk of tooth decay (Arumugam 2010), Higher concentration of fluoride causes dental and skeletal fluorosis, BIS and WHO standards for fluoride is 1.5 mg/l, values were found ranging between 0.2 mg/l to 3.9 mg/l in study area. 58 percent samples are found to be value higher than permissible limit of Fluoride prescribed by BIS, 2012) and WHO (2017for drinking water (Table-2)).

Nitrate: Hence, increasing nitrate contamination seriously threatens public drinking water supply and human health. Anthropogenic activities are considered main source of nitrate concentration in groundwater. Nitrate concentration ranges from 1 mg/l to 56 mg/l in the study area. Except a few sampling points, the study area is falling under the desirable limit as shown in Table 1. Nitrate concentration exceed above 45 mg/l (BIS, 2009), causes gastric cancer, methemoglobinemia (blue baby syndrome), thyroid disease and diabetes (Krishna Kumar et al., 2011).

Iron: The iron occurs naturally in the aquifer but levels in groundwater can be increased by dissolution of ferrous borehole and handpump components. Iron-rich groundwater is often orange in colour, which discolor clothes when washed, and also has an unpleasant taste, which is evident when drinking and cooking. Iron values were found ranging between 0.02 mg/l to 4.1 mg/l. BIS standard permissible limit for Iron for drinking water<0.3mg/l as well as WHO (2012) has fixed it to be <0.3 mg/l.

Table 2: Statistical groundwater quality parameter compared with BIS (2012) and WHO (2017).

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S.NO.	Parameter	Minimum	Maximum	Mean	Standard Deviation	BIS (2012)10500		WHO (2017)
						Desirable limit	Permissible Limit	
1.	**TDS**	610	8160	2624	1987.22	500	2000	500
2.	**EC**	940	12855	3084	3009.52	-	-	750
3.	**TH**	205	1920	684	370.16	200	600	500
4.	**F^-**	0.22	3.9	1.75	0.76	1	1.5	1.5
5.	**Cl^-**	54	2481	892.4	677.63	250	1000	250
6.	**Ca^{2+}**	22	193	61.3	31.75	75	200	75
7.	**Mg^{+2}**	44.4	419.6	150.7	81.96	30	100	30
8.	**NO_3^{-1}**	1	56	26.67	14.10	45	-	50
9.	**Fe**	0.02	4.1	1.0214	1.00	0.3	-	0.3

Water Quality Index (WQI): The WQI value and water type of the individual samples are presented in Table-1. The WQI values in the study area ranged from 47.41 to 489.39. The overall WQI clearly indicates that the quality of groundwater in study area belongs to poor categories as for as portability for human consumption is concerned.

Table 3: -Water Quality Index of the Study Area

S. No.	Sample Site Name	WQI	Water Quality
1.	Hayatpur Village	139.33	Poor water
2.	SMT Shanti Devi Secondary School, Jugsana	248.00	Very poor water
3.	Baldeo Chauraha	127.62	Poor water
4.	Near Mandir Dauji, Baldeo	123.71	Poor water
5.	Mahavan-Bangar, Near Madan Kheer Mohan Waale	157.77	Poor water
6.	Shergarh Chauraha	214.07	Very poor water
7.	Chhata, Goverdhan Road	181.86	Poor water
8.	Dautana	237.38	Very poor water
9.	Akbarpur	413.36	Unsuitable for drinking purpose
10.	Kosikalan, Mathura-Delhi Road Highway	489.39	Unsuitable for drinking purpose
11.	Jait village	191.11	Poor water
12.	Near Chaumuhan Chauraha	225.39	Very poor water
13.	Akbarpur Village	162.00	Poor water
14.	Ahuri	140.08	Poor water
15.	Ajhai Khurd	149.47	Poor water
16.	Near Toll plaza -Agra- Delhi Road	344.98	Unsuitable for drinking purpose
17.	Farah-Main Bazar	139.79	Poor water
18.	Luhara Village	155.92	Poor water
19.	Daulatpur Village	86.750	Good water
20.	Barari Village	154.18	Poor water
21.	Malhu at banJar Penth	136.68	Poor water
22.	Sakitara, Near Primary Pathshala	171.38	Poor water
23.	Palson village	151.33	Poor water

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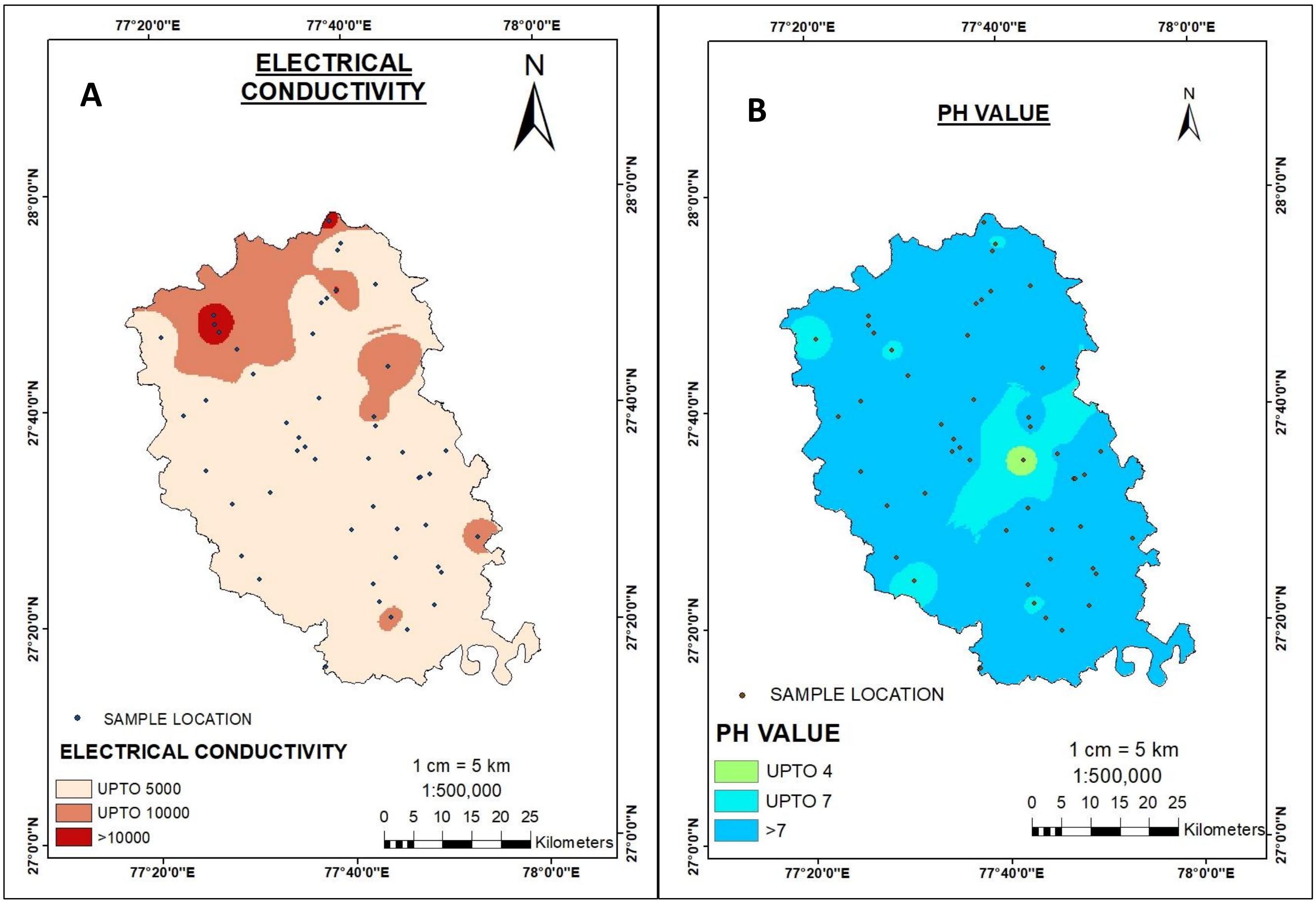
24.	Sonkh Dehat,	148.50	Poor water
25.	Chandauli Village	139.64	Poor water
26.	Near Nahar(canal), Raya-Mant Road	47.41	Excellent Water
27.	Mant Tehsil	107.40	Poor water
28.	Near Primary School, Chhahri Village	295.51	Very poor water
29.	Ram Nagala Village	158.98	Poor water
30.	Taitigaon, at Tiraha	298.51	Very poor water
31.	Aganpura Village	103.04	Poor water
32.	Near GLA University	135.22	Poor water
33.	Vrindavan khadar	207.94	Very poor water
34.	Jhikhangaon Village	177.79	Poor water
35.	Lakshiminagar Tiraha	157.88	Poor water
36.	Lodhauli Village	135.65	Poor water
37.	Near Petrol Pump, Barsana	94.23	Good water
38.	Kadauna, Near Primary School	83.80	Good water
39.	Kosikalan, Gopal Nagar	415.01	Unsuitable for drinking purpose
40.	Hasanpur Nagla	356.03	Unsuitable for drinking purpose
41.	Baghai Bangar Village	146.92	Poor water
42.	Holi Chowk, Shergarh-Naujheel Road	74.860	Good water
43.	Makhdoompur village	79.540	Good water
44.	Birju Garhi village	425.08	Unsuitable for drinking purpose
45.	Hasanpur village	355.94	Unsuitable for drinking purpose
46.	Infront of Momin Mosque, Sultan Ganj	119.36	Poor water
47.	Katra Bazar (Raya), Near Agrasen Chauk	153.81	Poor water
48.	Karab Village, Near Kachaudi stall, Baldeo-Raya Road	109.95	Poor water
49.	Koyal village, Hathras-Aligarh-Raya Road	91.790	Good water
50.	Gaju Village	118.86	Poor water

Spatial distribution characteristics: - Figure 2 shows the analysis for various physio chemical parameters by using inverse distance weight interpolation in a GIS environment. Large variations in Electrical conductivity (EC) concentrations are observed in figure 2A. The highest concentrations are noticed at the north and western Mathura blocks. Figure 2B shows the spatial distribution of pH concentrations, most of the study area are covered under the permissible category except for some patches in central and southern, northwest and southwest Mathura. The Total hardness (TH) concentration map shown in figure 2C suggests that TH found highest for the whole of Mathura district. Figure 2D shows the Total dissolve solids (TDS) observed above the permissible limit in north, south and some patches south-eastern part of the study area; whereas calcium concentration is highest whole of mathura district (figure 2E), Magnesium is also found in the non-permissible category for the entire Mathura except minor patches in south-eastern, central in figure 2F. Concentration of Fluoride observed in permissible limit only in southern part of the study area except some sampling site in figure 2G. The highest concentration of chloride recorded in north and some patches in south- east suggests in figure 2H. The Nitrate recorded in permissible limit in entire study area except minor patches (figure 2I) while the value of iron concentration found in non-permissible limit except south-eastern part of Mathura district (figure 2J). It can be observed from our study that most parts of the Mathura district have a high amount of TDS, EC, Ca, Mg, Iron, Fluoride and Cl, concentrations. Improper use of nitrogen in the form of fertilizers in agricultural fields increases the possibility of leaching of nitrates into groundwater in Mathura and adjacent districts. Previous studies have reported high concentrations of nitrate in Agra district (UPGWD, 2017). Other sources of nitrogen input such as sewage waste, natural soil, animal excreta and their dilution due to rainfall should be considered most relevant for the Mathura region.

Figure 2: Spatial distribution of Inverse Distance Weight (IDW) map of various physio-chemical parameters analysed for Mathura district, India: A) Electrical conductivity, B) pH, C) Total Hadness, D) Total dissolve Solids, E) Calcium, F) Magnesium, G) Fluoride, H) chloride, I) Nitrate and J) Iron.



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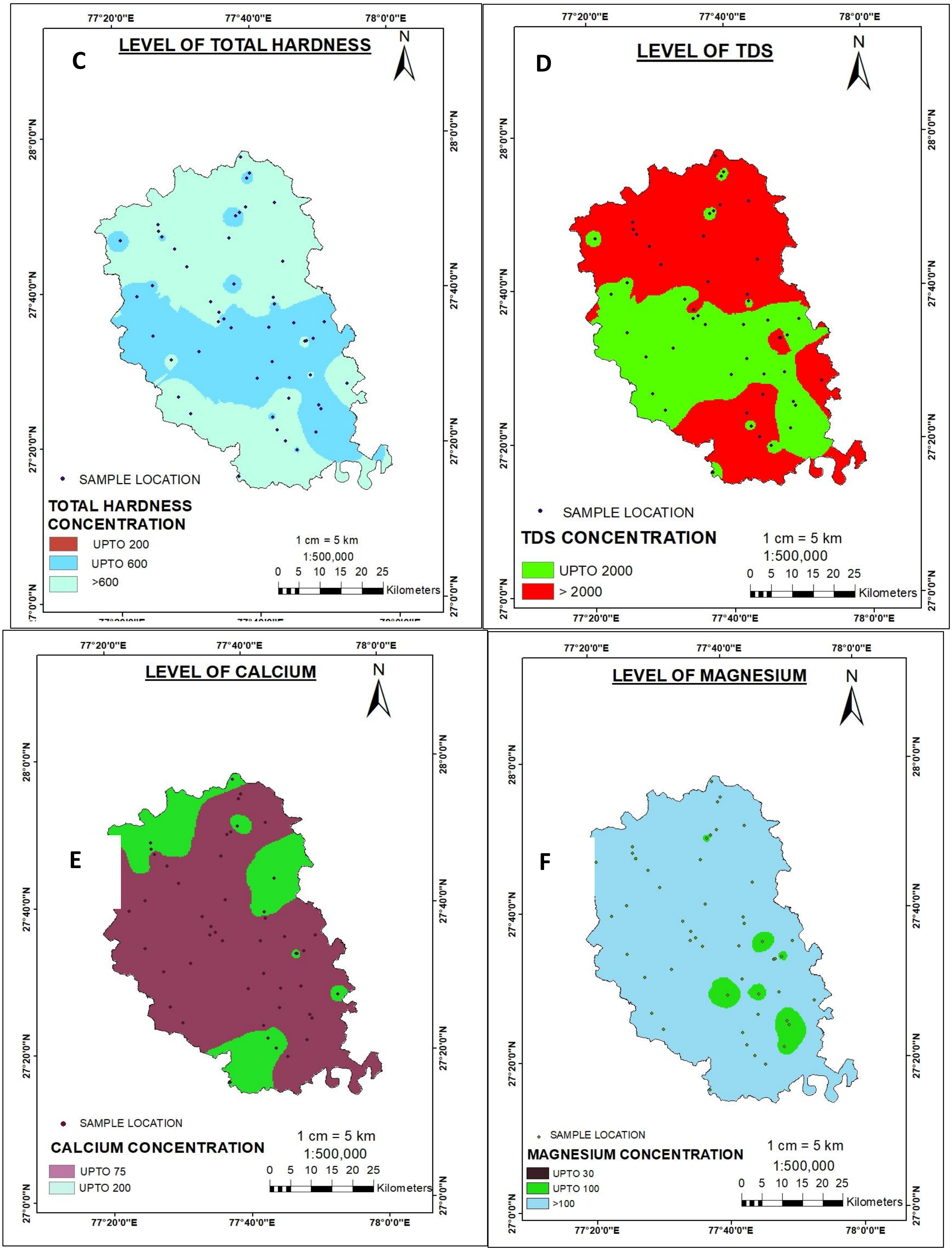

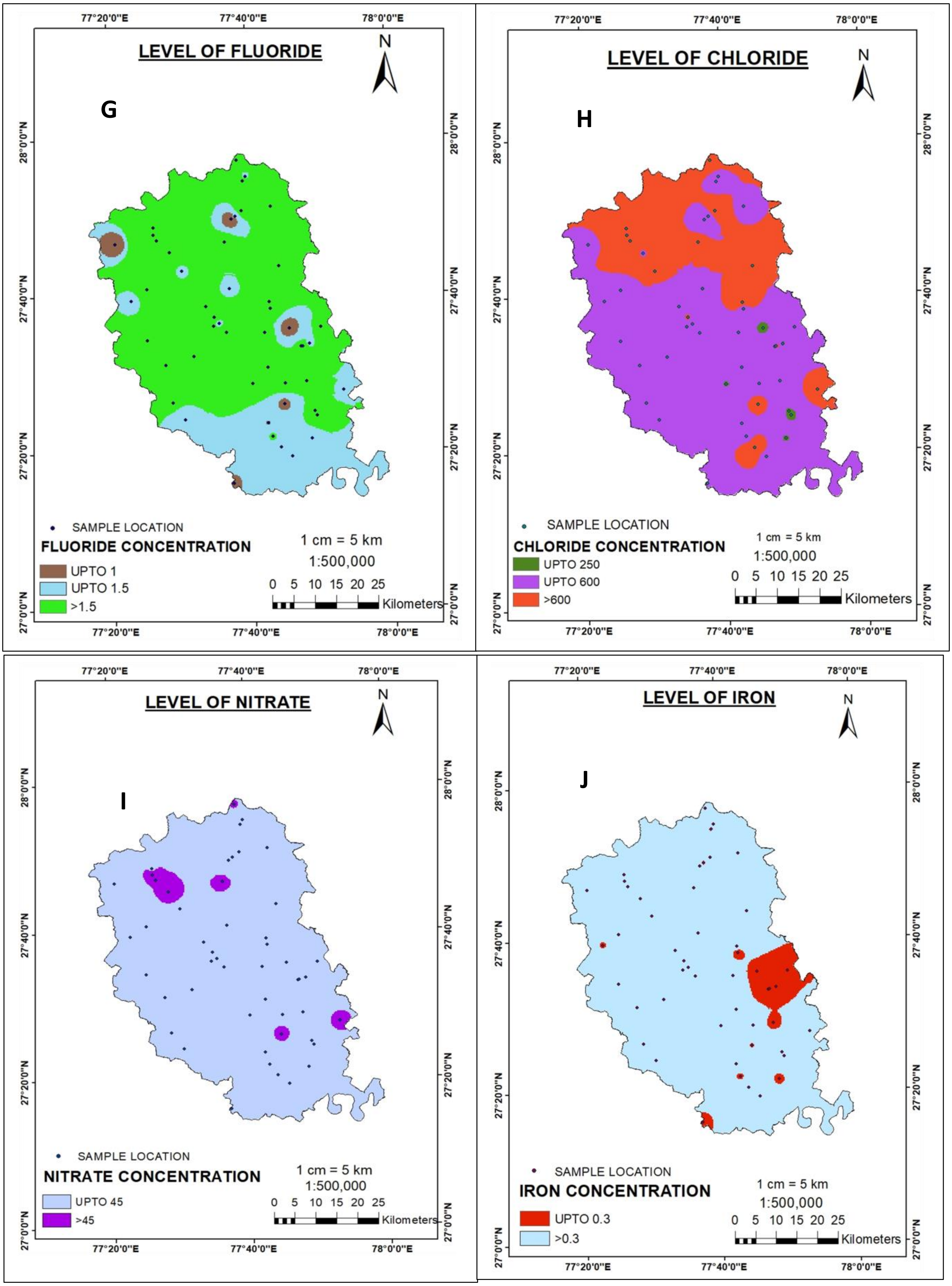
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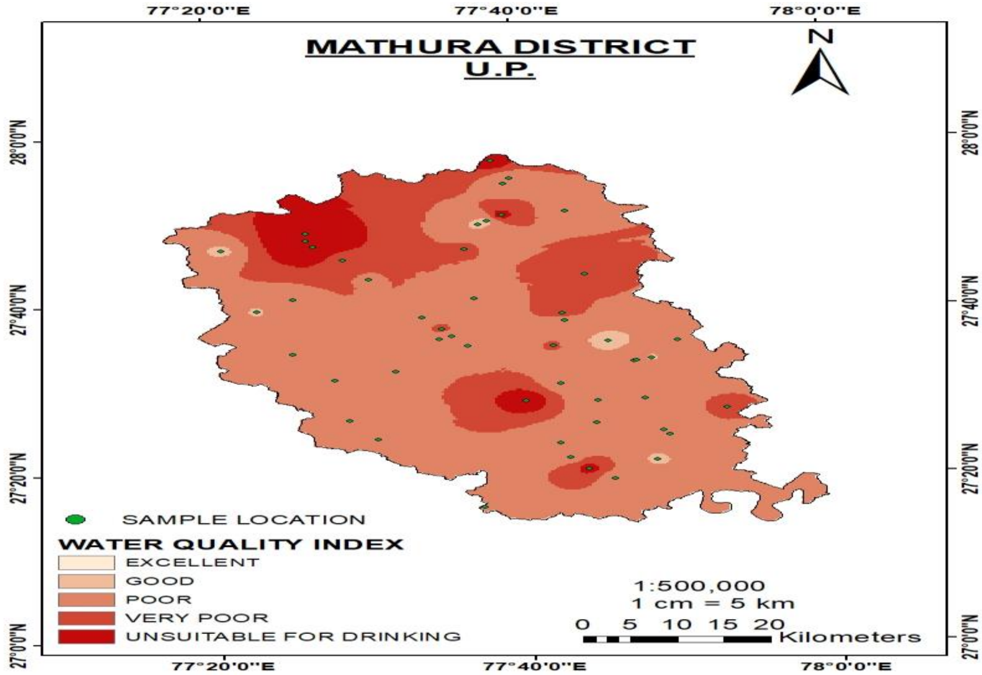


Fig 3: -Water quality index of Mathura district.

The impact of Groundwater pollution is very vast, problems related to it reported from the sampled respondents from the various income households/people respondents in Mathura Paralysis), Kidney stone, blue baby syndrome, hair and skins problems etc. The detail of patients related to each selected waterborne disease is given in figure 4.

Table 4 and fig.4 shows the distribution of sampled respondents according to the reported problems occurring due to ground water pollution. Of the total sample, nearly 67.5 percent reported that they suffered from problems. Of which, nearly all reported about Fluorosis (including teeth and Joint related Problems) 50 percent, Kidney stone formation (27.54 percent), and Typhoid (25.56 percent), cholera (19 percent), Blue Baby Syndrome (1.40), Hepatitis A (2.27 percent), and cases related to the any other problems (51.47 percent) like Dysentery, Diarrhea, stomach, hair and skins problems and Polio (Infantile Paralysis).

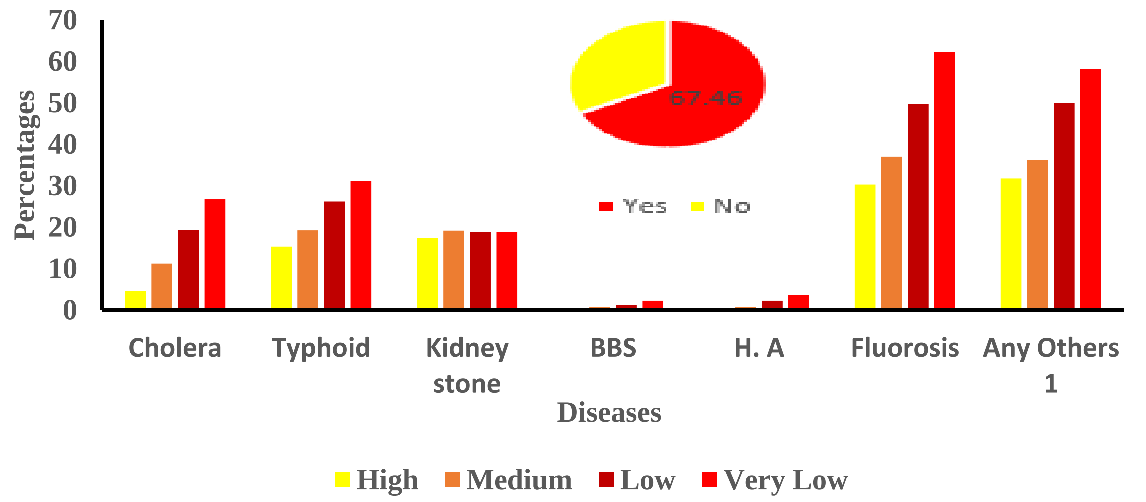
Table 4: Major Diseases related to the Ground water pollution

highlight without text	Number of sampled households/ people respondents	Problems/Diseases due to Groundwater pollution								
		If yes (type of Problems/Diseases)								
		Yes	No	Cholera	Typhoid	Kidney stone	BBS	H. A	Fluorosis	Any Others [1]
Total	2500	67.46	32.54	19.02	25.56	27.54	1.40	2.27	49.79	51.47

BBS- Blue Baby Syndrome—Hepatitis A, Fluorosis (including teeth and Joint related Problems)

1 Any others include Dysentery, Diarrhea, stomach, hair and skins problems, Polio (Infantile Paralysis).

Fig 4: Major diseases related to the Ground water pollution



Conclusion

The overall Groundwater Quality Index (WQI) of study area clearly indicates that the groundwater quality in Mathura district is in the poor category for human consumption. Hence, the study concludes that groundwater in the study area is not fit for direct consumption which is a major cause of waterborne diseases along with poor sanitation and lack of awareness. It is suggested that proper treatment methods and measures should be implemented before use of water for drinking purpose. The dominance of waterborne diseases in the study is due to both anthropogenic activities and natural geological setting. The role of local government representatives and relevant NGOs is also important to provide alternative sources and facilities of safe drinking water, to raise the awareness amongst the community. The local government should provide better health facilities to control the spreads of diseases associated with groundwater pollution through medication.

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